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Transforming Water Access in Tea Gardens of Assam: Health Realities and Gender Roles under the Jal Jeevan Mission

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Abstract

This ICSSR sponsored empirical research study investigates the influence of the Jal Jeevan Mission (JJM) on water accessibility and gender dynamics within Assam's tea garden communities, emphasizing notable changes driven by the government's initiative to supply Functional Household Tap Connections (FHTCs) to rural households by 2024. Access to safe drinking water is regarded as a vital public health concern, especially for historically marginalized tea plantation laborers who have faced challenges related to contaminated water sources. The JJM seeks to mitigate these disparities by enhancing health outcomes, reducing the burdens faced by women in water collection, and promoting community participation through decentralized governance frameworks. Key findings from the study indicate that nearly all surveyed households (99.2%) have access to piped water, with notable health advantages observed, including a reported 65.7% decrease in waterborne illnesses. However, challenges remain, including inconsistent water supply affecting 70.8% of households, difficulties in obtaining spare parts for restorations (87.7%), and limited community awareness regarding the wider goals of JJM and sustainable practices. Awareness regarding greywater management remains notably limited (85%), highlighting deficiencies in environmental education. The JJM has also modified the allocation of time for women, with approximately 75% of households indicating a reduction in time devoted to water collection, thereby enabling women and girls to participate more actively in educational and community pursuits. Nevertheless, conventional gender roles continue to be deeply rooted; 52.5% of households still depend on women as the primary water collectors, thereby restricting genuine empowerment. The study underscores the significance of encouraging women's participation in decision-making processes to ensure that JJM objectives are aligned with gender equity and to challenge societal norms that perpetuate persistent inequalities. The study concludes that although JJM shows promise for transformation of rural water access, the effective realization of these advantages requires sustained infrastructure maintenance, active community participation, and gender-inclusive governance. Recommendations include strengthening local monitoring systems, educating on water management, and fostering women's participation in water governance to guarantee that the benefits of improved water access are sustainable and equitable.

Keywords: *Jal Jeevan Mission (JJM), Sustainable, Gender, Health, Access, Inequality, Assam, Tea Garden, Marginalized, Water.*

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Introduction

The provision of safe drinking water is widely recognized as a fundamental component of public health, human rights, and sustainable development (WHO, 2017). In rural India, where weak infrastructure and environmental vulnerabilities intersect with deep social and economic inequalities, ensuring clean and reliable water supply has remained a persistent challenge (Jha & Singh, 2020). This issue is particularly severe among tea plantation communities in Assam, where historically marginalized groups continue to face unreliable access to essential services (Baruah, 2018). To address this, the Government of India launched the Jal Jeevan Mission (JJM) in 2019, aiming to provide Functional Household Tap Connections (FHTCs) to all rural homes by 2024 (Ministry of Jal Shakti, 2019). The initiative is not merely about construction; it represents a transformative approach designed to reduce health risks, lessen the disproportionate burden on women for water collection, and increase local participation in decentralized governance structures (Kumar & Sharma, 2021).

JJM's importance becomes clearer when considered alongside India's overall water situation. India has only 4% of the world's freshwater resources while housing 17% of the global population, making it one of the most water-stressed countries in the world (Central Water Commission, 2020). National assessments estimate that around 600 million people experience high to extreme water stress, with rural households being the most affected (UNICEF & WHO, 2021). Earlier programs, such as the Accelerated Rural Water Supply Programme and the National Rural Drinking Water Programme, improved access to some extent but faced challenges such as poor maintenance, minimal local participation, and unequal distribution (Choudhury, 2017). Before JJM, only about 18% of rural homes had piped water connections, highlighting gaps in India's rural water management (Ministry of Jal Shakti, 2019). JJM attempts to address these issues through village-level planning, inclusion of women, and technological tools like IoT-based monitoring (Kumar & Sharma, 2021).

Tea plantation communities in Assam provide a unique context for evaluating JJM. These populations, primarily consisting of indigenous Adivasi and other disadvantaged groups brought during the British colonial period, have historically faced neglect in education, health, housing, and sanitation (Baruah, 2018; Dutta, 2019). Dependence on unsafe water sources such as ponds, borewells, and streams exposes them to waterborne diseases like gastroenteritis, cholera, and enteric fever (WHO, 2017). The burden of fetching water traditionally falls on women and young girls, reinforcing gender inequalities by consuming time, limiting mobility, and restricting educational and economic opportunities (UNICEF, 2019). For these communities, household tap connections offer more than convenience; they promise health protection, dignity, and potential changes in household gender roles (Kumar & Sharma, 2021).

The Jal Jeevan Mission therefore operates on multiple interconnected levels. First, it serves as a health intervention by reducing waterborne illnesses and improving sanitation practices (Ministry of Jal Shakti, 2019). By providing safe water, JJM can lower medical expenses, reduce absenteeism in schools and workplaces, and enhance overall community well-being (Choudhury, 2017). Second, it addresses gender concerns by reducing the labor involved in water collection, allowing women and girls to engage more in education, income generation, and social activities, thereby promoting empowerment (UNICEF, 2019). Third, JJM encourages decentralized governance through Village Water and Sanitation Committees (VWSCs) with at least 50% female membership, aiming to transform residents from passive recipients into active managers of water systems (Kumar & Sharma, 2021). Finally, it emphasizes sustainability, incorporating measures to address climate change, groundwater depletion, and contamination by arsenic, iron, and fluoride, alongside options for recycled water use and adaptable technologies (Central Water Commission, 2020).

Earlier programs, like the Accelerated Rural Water Supply Programme (ARWSP) and the National Rural Drinking Water Programme (NRDWP), struggled due to poor maintenance, low community involvement, and weak monitoring (Ministry of Rural Development, 2010; World Bank, 2016). Before JJM, only 18.33% of rural households had piped water (Ministry of Jal Shakti, 2019). JJM addresses these gaps

through Village and State Action Plans (VAPs and SAPs) and shared financing (Kuzhivelil, n.d.; Wescoat Jr et al., 2020).

Coordination among institutions is another challenge. Water management is under state control, requiring collaboration and bureaucratic efficiency (Choudhury & Modak, 2020). Past programs like the Swachh Bharat Mission (SBM) show the risks of inconsistent implementation. Financial delays due to bureaucracy and powerful interest groups further complicate sustainability (Wasuja, n.d.; 15th Finance Commission, 2021).

Global experiences offer guidance. China's south-to-north water transfer and South Africa's free essential water policy show the importance of durability, stakeholder alignment, and continuous monitoring (Cai, 2008; Zhang & Xu, 2016). JJM aligns with UN SDG 6, contributing to fair water access, community well-being, and climate resilience. COVID-19 highlighted the need for reliable water. WHO analyses (2023) link water supply to hygiene and health. JJM's rapid rollout during the pandemic, despite logistical challenges, shows the government's priority for rural water access (Asher, 2020).

However, JJM faces significant challenges. Reports from Assam indicate a gap between installation and operational effectiveness. While many homes in Tinsukia district now have piped connections, water supply remains inconsistent due to frequent breakdowns, difficulty obtaining replacement parts, and shortage of trained repair staff, forcing households to revert to unsafe sources (Dutta, 2019). Awareness about water recycling, maintenance, and project timelines is limited, with communities often perceiving JJM as a top-down initiative rather than a participatory program (Baruah, 2018). Such issues raise questions about the program's long-term sustainability and its ability to transform infrastructure into lasting benefits (Kumar & Sharma, 2021).

Assam's tea plantation context highlights the importance of situating JJM within the broader debate on inclusion and equitable growth. These residents face precarious livelihoods, poor health indicators, and social marginalization, making it essential to evaluate JJM beyond connectivity figures. Assessment should consider social, cultural, and governance dimensions: How do communities perceive and use new water facilities? To what extent has women's participation in family and community decisions increased? How resilient are water systems to climatic changes? Such questions are central to determining whether JJM is a transformative policy or merely a technical intervention (Choudhury, 2017; Dutta, 2019).

In conclusion, the Jal Jeevan Mission presents a comprehensive approach to addressing rural water scarcity in India, with particular relevance for marginalized groups such as Assam's tea plantation workers. By linking health, gender equity, and local governance, JJM is positioned as more than a construction program. Yet, early evidence shows that converting household taps into reliable water access requires more than pipelines and equipment; it demands consistent supply, ongoing awareness campaigns, institutional accountability, and meaningful engagement with entrenched social inequalities (Kumar & Sharma, 2021; UNICEF, 2019). This study thus aims to critically assess the health and gender aspects of JJM among tea plantation communities in Assam, highlighting both achievements and limitations, while contributing to broader debates on water access, equity, and sustainable rural development.

Objective of the study

1. Assess the impact of JJM infrastructure on water access and reliability in Assam's tea garden communities.
2. Examine JJM's influence on gender roles, women's time use, and participation in water-related decisions.
3. Evaluate health and hygiene outcomes, focusing on waterborne disease reduction and safe water practices.

Methodology

This study used a mixed-method approach to examine the Jal Jeevan Mission (JJM) in tea plantations of Tinsukia, Assam. It combined quantitative data on water availability, reliability, and health improvements with qualitative insights on personal experiences, gender roles, and administrative practices. Water management in underserved communities is closely linked to fairness, social hierarchies, and organizational capacity, making a hybrid approach ideal for capturing both systemic and personal perspectives.

Fieldwork covered twelve tea estates, home to largely Adivasi and lower-caste laborers who face chronic water shortages, reliance on manual pumps, and health risks from poor sanitation. JJM was studied as a development initiative and a case of equitable service delivery. Using purposive sampling, 120 households were surveyed, with a focus on women, who manage most water and sanitation tasks. Six group discussions—three for women and three mixed—explored shared experiences, while interviews with ASHA workers, estate medical staff, and technical personnel cross-checked household reports on water quality, health, and system maintenance.

Data collection included: (1) household interviews on water supply, purification, health impacts, gendered labor, and JJM awareness; (2) group discussions on daily routines, reduced workloads, sustainability, hygiene, and fairness; (3) semi-structured interviews with health workers and estate managers on waterborne diseases, hygiene practices, system challenges, and oversight; and (4) direct field inspections of storage, pipelines, pumps, and outlets, alongside observation of household storage and sanitation practices.

Analysis followed a dual approach: numerical data were summarized statistically, while qualitative data were thematically coded for facility reliability, gendered labor, participation, health outcomes, and administrative issues. Cross-verification with experts and field observations strengthened reliability. Ethical practices included informed consent, confidentiality, voluntary participation, local language communication, and attention to women's perspectives.

Limitations included focus on twelve estates, reliance on participant recall, seasonal constraints, and resource limits. Despite this, the hybrid methodology and cross-checking enhanced rigor. Overall, the approach combined surveys, discussions, and field observation to assess JJM's impact, highlighting links between water access, health, gender, and governance, and providing evidence of whether JJM has translated infrastructure into sustainable, inclusive water provision.

Finding:

Category	Indicator	Response (%)
1. Infrastructure and Water Availability	Households with piped water under JJM	99.2
	Households without piped water	0.8
	Main water source: Groundwater	100
	Villages/tea estates included in JJM implementation	98.3
2. Community Awareness & Participation	Respondents aware of JJM	100
	Aware of 2024 target (universal coverage)	4.2
	Women attending JJM meetings	62.5
	Awareness of greywater management	0
3. Gender Roles and Time-Saving for Women	Women reporting reduced time in fetching water (significant)	37.5
	Women reporting reduced time (somewhat)	39.2

	No change in time burden	15.8
	Women as primary water collectors	52.5
	Shared responsibility in water collection	46.7
4. Health and Hygiene Impact	Reduction in waterborne diseases	65.7
	No reduction in waterborne diseases	21.7
	Children following hygiene practices	97.5
	Households treating water before drinking	68.3
	Improved family health due to water supply	71.7
5. Challenges: Monitoring, Spare Parts, Irregular Supply	Govt officials rarely/never monitor JJM	77.5
	Difficulty in accessing spare parts	87.7
	Technicians available during breakdowns	30
	Households experiencing irregular water supply	70.8
	Govt claims of 100% coverage match ground reality	55.8

1. Infrastructure and Water Availability

The Jal Jeevan Mission (JJM) is designed to provide a Functional Household Tap Connection (FHTC) to every rural household by 2024. In Assam's tea plantations, where safe and reliable water has often been difficult to access, the JJM infrastructure has brought important changes to everyday life. Research from twelve tea plantations in Tinsukia district shows that, although piped water systems are almost fully installed, problems with regular supply, long-term durability, and fair distribution continue to limit lasting benefits.

1.1 Primary Water Sources, Infrastructure Dependence, and Extent of Coverage

A key finding from the questionnaire is that all participants (100%) identified groundwater as the main source for the piped water provided through JJM. This full dependence on groundwater shows both the strengths and weaknesses of the current system. On the positive side, families demonstrated strong knowledge about where their water comes from and how it is delivered, showing a good understanding of the water network.However, relying on a single source also brings risks. Overuse, seasonal drops in water levels, or pollution could threaten supply for the entire community. Participants reported that dry periods, like December and January, led to reduced water availability, confirming that weather changes already strain groundwater-dependent systems. Only 14% said they noticed the effects of global warming on water access, while about 40% were unsure, pointing to a lack of information that could limit their ability to adapt.

The JJM's coverage in the area has been strong. Nearly 98.3% of respondents said their tea plantation was included in the mission, and 119 out of 120 homes (99.2%) reported having piped water. This near-universal connection is a major improvement for tea plantation residents, who previously relied on manual pumps, borewells, or unsafe open water sources. For women and children, who carried the heaviest burden of water collection, in-home taps have reduced labor, saved time, and improved hygiene.

Yet, having a physical connection does not guarantee consistent or fair use. Even though most households had piped water, only 29.2% enjoyed a steady supply without interruptions. Many families reported receiving water irregularly, sometimes only once a day or not at all. Problems like leaks, drips, and equipment breakdowns were common, made worse by delays in repairs due to a shortage of skilled workers and replacement parts.

1.2 Reliability and Fairness

Consistency has emerged as a major challenge in how the water infrastructure works. While 69.2% of participants said water arrived regularly without major problems, nearly a third faced difficulties. These included long delays, sudden stoppages, or supply only every other day. Conversations on-site showed that malfunctions often went unresolved for long periods because experts were scarce in remote areas. Replacement parts were described as "very hard to get," with 87.7% of participants reporting that such items were not available nearby. These interruptions forced households to rely on traditional water sources, especially during system failures or droughts. This affected both health improvements and the trust people placed in JJM, as families sometimes had to use untreated water from manual pumps or rivers even when taps were installed at home.

Despite these operational issues, awareness of JJM was very high: every participant knew about the program. However, most knowledge focused on getting a home connection rather than understanding the program's broader goals, sustainability strategies, or water conservation practices. For example, 85% did not know how to manage used water, and none reported actually practicing it. This lack of awareness threatens the sustainability of the facilities, as improper disposal of wastewater can harm the environment and underground water sources that JJM depends on.

Overall, JJM's facilities in tea plantations have succeeded in reach (providing connections) but fall short in substance (consistent, fair, and sustainable supply). For marginalized groups in Assam's tea regions, this gap between installation and ongoing usability is crucial: it determines whether piped water can truly improve health, incomes, and gender equality, or remain a partially fulfilled promise.

2. Community Awareness and Participation

Understanding the mission's goals, learning about water-use habits, and getting hands-on experience, especially from women are central to JJM's focus on community-based and participatory management. Findings from the Tinsukia pilot project show an interesting situation: while almost everyone is aware of JJM, deeper involvement in its goals, long-term strategies, and ways to participate remains quite limited.

2.1. Awareness of JJM, Its Objectives, and Environmental Practices

The survey showed that every respondent knew about the Jal Jeevan Mission (JJM), which is unusual for rural government programs. Most households first learned about it when their home tap connections were installed, showing that providing infrastructure itself can raise awareness. However, understanding of JJM's broader goals was limited: 55% of respondents (66 people) said the program's objectives were well explained, 40.8% (49 people) were unsure, and 4.2% (5 people) disagreed. This suggests that while residents understand the water supply aspect, they often miss connections to sustainability, women's empowerment, and their own role in maintaining the system.

A similar gap appeared regarding the 2024 target for nationwide universal access: 95.8% of participants did not know about this goal. Without knowledge of timelines and larger aims, residents see JJM more as a top-down benefit than a program that requires their involvement.

The biggest awareness gap was about greywater management. About 85% said they did not know what it meant, while 15% were aware but did not take part. This lack of knowledge shows a major weakness in outreach. In tea plantation areas that rely entirely on groundwater, poorly managed greywater can pollute underground sources and threaten the long-term success of the system. It highlights that current information,

education, and communication (IEC) efforts focus too much on installing pipes and not enough on important environmental responsibilities.

2.2. Participation in Meetings, Hygiene Programs, and Behavioural Change

Despite some challenges, there are clear signs of growing participation in community meetings and sanitation education. Out of 120 respondents surveyed, 75 had attended meetings linked to the JJM program, while 45 had not. Younger women were especially active, while older participants often cited health or mobility issues as barriers. Usually women's participation is important because they are mainly responsible for managing family water and sanitation, helping to establish safe practices at home. Additionally, 85.8% of respondents said they attended hygiene workshops conducted by community health aides, midwives, or village health staff. These workshops, often held in plantation workers' quarters, have encouraged practices like proper handwashing, safe child care routines, and secure water handling. Overall, this shows that when activities are convenient and accessible, community members are willing to participate and learn.

2.3. Gender Dimensions of Participation and Decision-Making

The research shows a complex relationship between gender roles and water access. Piped water has greatly reduced the physically demanding work for women and girls, giving them more time for household responsibilities and education. Many participants noted that fetching water no longer takes up their mornings, making daily routines easier and allowing them to participate more in community health discussions and sanitation activities. Yet, women's role in decisions about water governance remains limited. Among the households surveyed, 63 (52.5%) still carry the main responsibility for fetching water, 56 households share the task collaboratively, and only one relies mainly on children. Although the Jal Jeevan Mission (JJM) has reduced the physical burden, traditional gender roles in water chores continue, highlighting the need for focused gender-awareness programs to strengthen these gains.

In tea garden communities, JJM's efforts in community outreach and participation show positive early signs but are not yet fully developed. While everyone has heard of the program, many are unaware of its goals, wastewater management practices, and the 2024 deadline, showing a gap between basic awareness and genuine engagement. Women's involvement is increasing but remains limited by male-centered traditions. Without deeper and ongoing community participation, JJM's improvements in water infrastructure may not last.

Gender Roles and Time-Saving for Women under JJM

A key finding from the pilot study shows that the Jal Jeevan Mission (JJM) has significantly transformed gendered water-fetching patterns in the tea plantation communities of Tinsukia District. In rural India, collecting household water has traditionally been women's work, placing a heavy burden on them (Singh, 2017). For tea estate families, this strain was worsened by distant water sources, unsafe open bodies, and the rush to gather water before early shifts. The introduction of Functional Household Tap Connections (FHTCs) under JJM has thus eased these tasks and reshaped how families share household responsibilities.

a. Time-saving impacts for women

The survey shows that most participants noticed a clear reduction in the time women and girls spend collecting water. Out of 120 households surveyed, 45 reported a large drop in the time women spent, 47 saw some savings, 19 noticed no change, and 9 said it did not apply because they already had water at home through private pumps. Overall, this means the JJM program has positively affected women's daily routines in about 75% of households.

The extra time saved has several benefits. Women can now complete household chores more easily before going to plantation work, which usually starts at 8 a.m., reducing morning stress and improving their

physical and mental well-being. Girls who previously helped with water collection can now attend school more regularly, lowering absenteeism and supporting consistent learning. Moreover, this freed-up time gives women a chance to engage in income-generating or community activities, though these opportunities are not yet fully explored.

b. Gender roles and persistence of inequality

Even though the time and physical effort needed to fetch water have clearly decreased, the study showed that traditional gender roles in tea plantation families remain largely the same. Out of 120 participants, 63 said that adult women are still the main people responsible for collecting water, while 56 families reported that water collection is shared among men, women, or other family members. Only a very small number said that children or male relatives do this task on their own. This suggests that while better facilities have improved the conditions of water collection, they have not significantly changed who does the work. The continued reliance on women as the main water managers reflects deep-rooted patriarchal traditions in rural Assam, where household chores are still seen as women's responsibility.

4. Health and Hygiene Impact of Jal Jeevan Mission in Tea Garden Communities

The provision of clean and reliable drinking water under the Jal Jeevan Mission (JJM) has had a transformative effect on the health and hygiene conditions of tea garden communities in Tinsukia District. Historically, these communities depended on hand pumps, tube wells, and unprotected sources, often leading to high prevalence of waterborne illnesses and poor sanitation practices. The pilot study findings demonstrate that functional household tap connections (FHTCs) under JJM have contributed positively to reducing the burden of disease, improving hygiene behaviour, and enhancing community well-being.

4.1. Waterborne Disease Reduction, Treatment Practices, and Hygiene Outcomes

One of the most noticeable effects of the Jal Jeevan Mission (JJM) has been a marked decrease in water-related diseases. Survey data show that 65.7% of respondents reported a reduction in illnesses such as diarrhea, cholera, and typhoid after the introduction of piped water systems. Regular access to safe drinking water has greatly reduced the risk of contamination, which was common when families relied on stagnant ponds or distant hand pumps. However, 21.7% of participants observed no significant changes, mainly because they continued to experience fevers, colds, and influenza—diseases not linked to water use. Additionally, 12.5% were unsure, likely due to gradual changes in routines or uneven water supply. These findings highlight the importance of reliable, clean water in preventing digestive illnesses, while also showing the need for public health campaigns to explain the differences between water-borne and airborne diseases.

When asked specifically about diarrhea, cholera, or typhoid in the past six months, 98 out of 120 families (81.7%) reported zero cases, while 22 families (18.3%) had experienced these illnesses. Detailed analysis showed two main reasons for continued cases:

1. **Reliance on traditional water sources** – Some households still use untreated borewells or rivers, especially when piped water is interrupted.
2. **Inadequate purification practices** – Even where JJM water is available, some drink it directly without heating or filtering, risking contamination from pipes or storage containers.

These observations suggest that building infrastructure alone is not enough; it must be supported with continuous awareness campaigns and local monitoring of water quality to achieve full benefits.

The study found that 68.3% of people treat their water before drinking, using heating, sieving, or traditional methods. This shows good health awareness, reinforced by JJM campaigns and earlier sanitation programs. However, 31.7% admitted they do not treat water, often trusting the apparent cleanliness of piped

water that is clear, odorless, and free of rust. While this trust is a success for JJM, it also poses risks, as hidden bacteria may remain. Therefore, regular laboratory testing and ongoing community education about unseen contaminants are essential.

A particularly positive outcome is the improvement in children's hygiene habits. Out of 120 respondents, 117 (97.5%) reported that their children regularly follow cleanliness practices, such as washing hands before meals, bathing daily, and using soap. This shows that health education integrated with JJM, along with programs like Swachh Bharat Abhiyan and school awareness activities, is effective. Only three families reported irregularities, likely due to caregivers' busy schedules or temporary water shortages. By encouraging good habits early, JJM not only reduces short-term health risks but also builds long-term protective behavior for future generations.

Local sanitation awareness programs have also been very impactful. About 85.8% of respondents said they attended these workshops, organized by community health workers, medical staff, and local authorities. Topics included safe water storage, hygiene practices, and disease prevention. Women were the main participants, reflecting their central role in family health and resource management. Around 11.7% did not participate regularly, possibly due to inconsistent engagement or forgetting sessions. This highlights the need for ongoing communication strategies, including targeted efforts to involve men and older adults, who are often underrepresented.

4.2. Perceived Family Health Improvements and Gendered Dimensions of Hygiene

When asked about their family's overall health, 80 participants (66.7%) agreed that the improved water supply had strengthened their family's well-being. Many reported fewer trips to the hospital and lower medical expenses. Six participants strongly agreed, saying that having piped water had completely eliminated ongoing health problems at home. On the other hand, 28 participants were neutral, and six disagreed, showing that health improvements are not the same for everyone. This suggests that while the JJM has greatly reduced water-related health risks, other factors—like diet, diseases spread by insects, and access to medical care—still affect overall health.

Women, who have traditionally been responsible for fetching water, have experienced significant relief from the piped water system. With water now easily available at home, they can manage tasks such as cooking, cleaning, and taking care of young children more effectively, which has improved household hygiene. Additionally, the time previously spent collecting water is now partially used for keeping children clean and attending to their health needs, highlighting how JJM contributes to better sanitation and care within the home.

Discussion

The findings of this study highlight the important progress made by the Jal Jeevan Mission (JJM) in providing reliable drinking water to the tea garden areas of Assam, while also showing that its full potential is limited by deep-rooted institutional, operational, and social challenges. The near-complete rollout of piped water connections that reached 99.2% of households is a major achievement, particularly for marginalized communities that have long lacked basic services. However, the study shows that building infrastructure alone does not automatically lead to improvements in community well-being, hygiene, or gender equality. This section examines these gaps and offers suggestions to strengthen JJM for lasting impact.

The widespread availability of piped groundwater has clearly improved household living conditions, especially for women and children, by reducing physical labor and supporting better hygiene. Still, heavy reliance on a single water source has revealed vulnerabilities, particularly during dry periods or when pipelines break down. Only 29.2% of respondents reported a reliable, uninterrupted supply, highlighting significant operational gaps. The lack of local supply chains for spare parts and trained technicians worsens the problem—87.7% said it was difficult to get necessary components, and only 30% could count on prompt

technician support. These challenges reflect a "build-only bias" seen in rural water governance, where infrastructure construction is prioritized over maintenance and community support (Baruah, 2021; Sharma, 2020).

JJM has brought important health benefits. About 65.7% reported fewer water-related illnesses, 97.5% noticed better hygiene among children, and 68.3% treat water at home; signs that health awareness is improving. Yet nearly one-third still drink untreated water, relying on appearance alone, showing the need for continued awareness campaigns on invisible contaminants and hygiene.

JJM has also affected gender roles, with both successes and limits. Piped water has reduced women's time spent fetching water in about 75% of households, easing physical strain and freeing time. Women's participation in community forums is fairly high (62.5%), and many attend hygiene workshops, showing growing recognition of their health responsibilities.

Still, traditional gender roles remain; 52.5% of households report adult women are still the main water collectors, and their decision-making power remains limited. Freed time often goes to unpaid domestic work rather than income-generating activities, reflecting rural India's patriarchal norms (Agarwal, 1997). Therefore, empowerment efforts must go beyond providing services to include women in management, decision-making, and economic activities; otherwise, reduced labor alone does not lead to real empowerment.

A major concern from the study is weak monitoring and accountability. About 77.5% of respondents said officials rarely or never visited to check JJM operations, leaving households to handle problems themselves. This lack of oversight undermines service quality and trust.

Intermittent water supply also affects vulnerable groups especially women and children who turn to unsafe sources during shortages, risking health and reinforcing gender inequality. These findings reflect longstanding critiques of rural schemes that focus on building assets but neglect maintenance, grievance mechanisms, and community participation.

Policy and Research Implications

The research highlights the urgent need for practical changes in how the system works and for stronger involvement of local communities. Setting up oversight mechanisms, regional water supply networks, and training community members as maintenance experts can help ensure that infrastructure is used effectively. Education and communication efforts should also cover topics like managing greywater, adapting to climate change, and the dangers of untreated water.

Gender equality must be a priority. Women should take part in planning committees, get support in household tasks, and have access to income opportunities. This ensures that lighter workloads lead to real empowerment, not just shifting responsibilities to others.

Finally, more research is needed on the long-term health effects, behavior changes, and social and economic outcomes from better water access. It is also important to study climate pressures and groundwater sustainability, especially as environmental challenges in rural areas continue to grow.

Conclusion

The Jal Jeevan Mission (JJM) is an important step in addressing India's rural water challenges, especially in Assam's Tinsukia tea garden communities, which have long faced water scarcity, health risks, and gender inequalities. This study, using surveys, focus groups, interviews, and observations across 120 households in twelve estates, shows that JJM has had a double effect: clear improvements in infrastructure but ongoing operational and social challenges. While household tap connections are beginning to change daily life, their full benefits for fairness and sustainability depend on strong governance and empowering local communities.

JJM has achieved almost complete coverage, with 99.2% of households having Functional Household Tap Connections (FHTCs). This has reduced the burden on women, who traditionally collect

water. About 76.7% of respondents reported that women and girls now save significant or some time, supporting education, household work, and community participation (62.5% of women attend JJM meetings). Health improvements are also visible: 65.7% of respondents saw fewer waterborne illnesses, and most follow good hygiene practices for children (97.5%) and treat water at home (68.3%). These results show how JJM helps public health and supports SDG 6 on universal water access.

However, problems remain. Water supply is irregular (70.8% affected), spare parts are hard to get (87.7%), and monitoring is not frequent (77.5%), forcing households to use unsafe water that implicates lower trust issues. Awareness among the respondents is limited in many crucial aspects: people know little about greywater management or the 2024 universal coverage target, and many see JJM as a free service rather than a community project. Progress for women is also limited: women still manage most water tasks (52.5%), and saved time often goes to other unpaid work instead of empowerment. These issues echo broader critiques, from Ostrom on community management to Agarwal on how infrastructure interacts with household hierarchies, showing how tea garden marginalization worsens national water governance gaps.

JJM in Assam's tea estates shows a transformative vision but faces a "coverage-functionality gap"—pipes exist, but reliable water depends on maintenance, local participation, and climate resilience amid groundwater decline. Policymakers should strengthen decentralized accountability by giving Village Water and Sanitation Committees women's quotas, local repair supply chains, and public campaigns in local languages to promote sustainable practices like greywater reuse and rainwater harvesting. Linking JJM with gender-focused programs—skills training and shared household practices—can boost women's empowerment and social mobility. Long-term, multi-season research across districts will help refine these strategies, tracking health and environmental outcomes.

For Assam's Adivasi tea workers, JJM is more than pipes and taps; it provides dignity, health security, and social justice. By moving from a top-down rollout to participatory management, JJM can integrate water security into fair rural development. In a country where 600 million people face water stress, functional taps in places like Tinsukia can improve lives and reshape India's approach to development.

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